Single-Axis Picomotor Driver

Model 8712 Picomotor Driver

Model 8703 System Driver
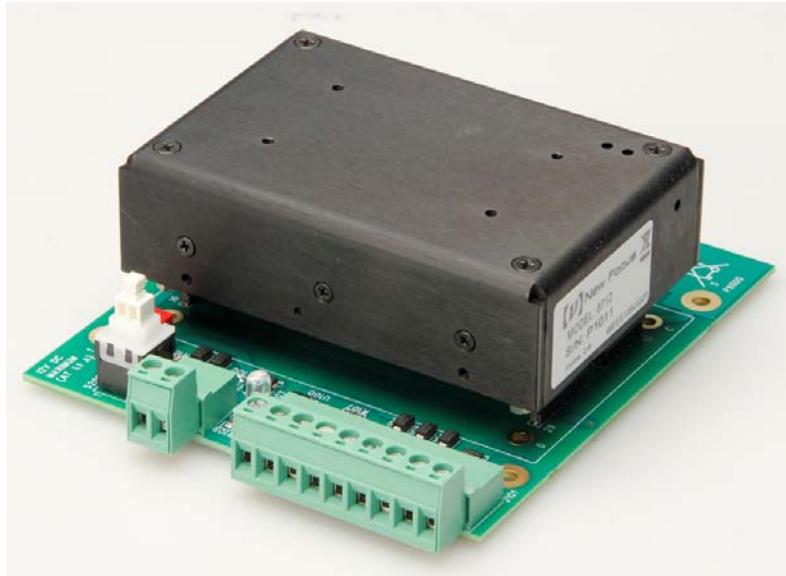
User's Manual

[ν] New Focus™
A Newport Corporation Brand

EU Declaration of Conformity

We declare that the accompanying product, identified with the $C\epsilon$ mark, complies with requirements of the Electromagnetic Compatibility Directive, 2004/108/EC and the Low Voltage Directive 2006/95/EC.

Model Numbers: 8712, 8703

Year $C\epsilon$ mark affixed: 2012

Type of Equipment: Electrical equipment for measurement, control and laboratory use in industrial locations.

Manufacturer: Newport Corporation
1791 Deere Avenue
Irvine, CA 92606

Standards Applied:

Compliance was demonstrated to the following standards to the extent applicable:

BS EN61326-1: 2006 "Electrical equipment for measurement, control and laboratory use – EMC requirements".

This equipment meets the CISPR 11:2009+A1:2010 Class A Group 1 radiated and conducted emission limits.

BS EN 61010-1:2010, "Safety requirements for electrical equipment for measurement, control and laboratory use".

Mark Carroll

Mark Carroll
Sr. Director, Instruments Business
Newport Corporation
1791 Deere Ave, Irvine, CA92606 USA

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First printing 2012

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New Focus
3635 Peterson Way
Santa Clara, CA, 95054
USA

Part No. 90051552 Rev B

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Technical Support Contacts

North America

New Focus

3635 Peterson Way, Santa Clara, CA 95054

Telephone: (866) 683-6287

Telephone: (408) 919-1500

Asia

Newport Opto-Electronics Technologies

中国 上海市 爱都路 253号 第3号楼 3层

C部位, 邮编 200131

253 Aidu Road, Bld #3, Flr 3, Sec C, Shanghai 200131, China

Telephone: +86-21-5046 2300

Fax: +86-21-5046 2323

Europe

Newport/MICRO-CONTROLE S.A.

Zone Industrielle

45340 Beaune la Rolande, FRANCE

Telephone: (33) 02 38 40 51 56

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E-mail: rma.service@newport.com

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- Your Contact Information
- Serial number or original order number
- Description of problem (i.e., hardware or software)

To help our Technical Support Representatives diagnose your problem, please note the following conditions:

- Is the system used for manufacturing or research and development?
- What was the state of the system right before the problem?
- Have you seen this problem before? If so, how often?
- Can the system continue to operate with this problem? Or is the system non-operational?
- Can you identify anything that was different before this problem occurred?

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1   Introduction

1.1   Introduction

The Model 8712 & Model 8703 Picomotor drive modules are ideal drivers for OEM Picomotor systems. Model 8712 is designed to be mounted on a printed circuit board (PCB). Model 8703 incorporates the Model 8712 with a PCB for quick and easy integration into your system. Key features and specifications are:

- 12V nominal power supply.
- Choice of 4 industry-standard analog and optically coupled digital motion-control interfaces.
- Idle control input for reduced power consumption and interlock.
- No motion caused by turn on/off transients.
- Instantaneous direction reversal.
- Continuous operation at up to 1 kHz in a still-air 55 ºC environment.
- 2 kHz maximum pulse rate at 25 ºC, intermittent operation at higher temperatures.
- Over-temperature auto protection
- Threaded holes on top and lateral sides for easy mounting

Step/direction, quadrature, and ±10V linear or bang-bang voltage control interfaces set the velocity and direction of a Picomotor connected to the drive module. Two mode inputs are used to select one of the four control interfaces when power is applied to the module. An optically isolated LIDLE input turns off the high-power circuits to reduce power consumption to 0.8 W (typical). The LIDLE input also disables Picomotor pulse generation.

1.2   Safety

Voltages of up to 130 V are accessible inside the driver chassis, mounts, Picomotors, and the interface board. DO NOT operate the units with the driver or mount covers removed. If the wire of a mount or Picomotor is damaged, discontinue use and return it for repair. If the device is used in a manner not specified by New Focus, the protection provided by the device may be impaired.

1.3   Operating Limits*

PARAMETER	MIN.	MAX.
Model 8712 Power input voltage (+V IN)	10 V	16 V
Model 8703 Power input voltage (+V IN)	10 V	12 V
Continuous pulse rate in 55 ⁰C still air	9.5 Hz	1 kHz
Ambient still-air operating temperature	0 °C	65 °C
Storage temperature (non-operating)	-40 °C	95 °C
Voltage on optically coupled output	0 V	5 V
Input voltage on optically isolated inputs	0 V	6.0V
Analog input voltage** (ANALOG IN–, ANALOG IN+)	-10 V	+10 V
Current into optically coupled input		10 mA

*Operating outside the operating limits may damage the unit.
**The magnitude of the analog input voltage must be less than the power supply input voltage.

2   Specifications

2.1   Electrical Specifications

All specifications assume a 1 kHz pulse rate, 12 V power input, 25° C still-air ambient, and TTL step/direction input, unless otherwise indicated.

PARAMETER	MINMUM	TYPICAL	MAXIMUM
Power Supply Voltage	10 V		16 V
Inrush Current at Power On		600 mA	
Idle Current Draw		75 mA	
Pulse Rates			
Step/Direction Mode	0		2 kHz
Quadrature Mode	0		2 kHz
Linear Voltage Mode	0		2 kHz
Bang-Bang Voltage Mode	0		2 kHz
Minimum Non-Zero Pulse Rate in Linear Voltage Mode		9.5 Hz	
Linear Voltage Mode Step Size	refer to Figure 11 and Figure 12		
Analog Threshold		±1 V	
ANALOG IN Input Impedance		14.1 kΩ	
Optically Coupled Input Series Resistance		470Ω/0.06W	
Package Thermal Time Constant		7 minutes	
Over-temperature LFAULT Trip Point at Temperature Monitor Output		4.00 V	
Over-temperature Shut-Down Trip at Temperature Monitor Output Point		4.12 V	
Weight	5.76 oz (163 g)		

		(L x W x H including standoffs)
	Dimensions	3.75 in x 2.53 in x 1.26 in
		95 mm x 64 mm x 32 mm

2.2   Model 8712 pin Descriptions

Pin	Name	Description
1	SYSTEM GROUND	Power return
2	+V IN	Input power, 10–16 V
3	+V IN	Input power, 10–16 V (same as pin 2)
4	SYSTEM GROUND	Power return (same as pin 1)
5	SYSTEM GROUND	Power return (same as pin 1)
6	SYSTEM GROUND	Power return (same as pin 1)
7	+5V OUT	Logic-supply output connected to a 1-kΩ resistor. Used for manufacturing test and mode configuration. Typical output voltage range is 4.8 to 5.2Volts DC (no load).
8	ANALOG IN–	Voltage-controlled rate input. Connect to analog common.
9	ANALOG IN+	Voltage-controlled rate input. Connecting to analog voltage ±10 V gives full-scale rate of 2 kHz. The input impedance is 14.1 kΩ to ground. Enabled by MODE 0,1 or 1,1 inputs.
10	DGROUND	Opto-coupler return. Connect to digital ground close to control logic.
11	DIR+/A	Opto-coupled TTL control input enabled by MODE 0,0 or 1,0 inputs. In Step/Direction mode, controls direction: high=clockwise, low=counterclockwise. In Quadrature mode, acts as quadrature A.
12	PULSE+/B	Opto-coupled TTL control input enabled by MODE 0,0 or 1,0 inputs. In Step/Direction mode, each falling edge initiates a step. In Quadrature mode, acts as quadrature B.

13 14	MODE0 MODE1	The MODE0 and MODE1 pins control the mode of the unit as follows:

MODE0	MODE1	Description
0	0	**Step/Direction Mode:** Digital mode where DIR+/A controls direction (high=clockwise, low=counterclockwise) and the falling edge of PULSE/B initiates each step.
1	0	**Quadrature Mode:** Digital mode where pulses are generated from edge transitions of both the A-phase (DIR+/A) and B-phase (PULSE/B) inputs.
0	1	**Linear Voltage Input Mode:** Analog mode where ANALOG IN+ controls pulse direction and rate. Negative voltage results in counter-clockwise motion: positive results in clockwise. See Figure 11 for the frequency-to-voltage correlation.
1	1	**Bang-Bang Voltage Input Mode:** Analog mode where voltage on ANALOG IN+ above the threshold results in maximum analog pulse rate. Polarity controls direction.

Mode bits are only read when power is turned on. They are not optically isolated. Tie them to +5V OUT or SYS GROUND.

15	LIDLE	Opto-coupled TTL input. Low input disables pulse generation and reduces power consumption. Can also be used as system interlock.
16	LFAULT	Open-collector opto-coupler output pulled low when output amplifier temperature limit is exceeded. On start-up, firmware version number is present on this pin in the form of on/off pulses.
17	N/C	Not connected pin.
18	+5V REF	Reserved. Test point for manufacturing reference only.
19	LV PULSE	Reserved. Test point for manufacturing reference only.
20	-15V	Reserved. Test point for manufacturing reference only.
21	TEMP MONITOR	Voltage proportional to the output-amplifier case temperature. If it goes above 4 V pulls LFAULT low.
22	GROUND	Ground reference for pin 21. Do not tie to SYS GROUND (pins 1, 4, 5 & 6).

23	+130V	Reserved. Test point for manufacturing reference only. Typical output voltage range is 120 to 138 Volts DC (no load).
24	PULSE RETURN	Drive pulse return. **Note:** PULSE RETURN and PULSE OUTPUT should be routed in close proximity. Other signal traces should be kept away from PULSE RETURN and PULSE OUTPUT.
25	PULSE OUTPUT	Drive pulse. **Note:** PULSE RETURN and PULSE OUTPUT should be routed in close proximity. Other signal traces should be kept away from PULSE RETURN and PULSE OUTPUT.
26	PULSE RETURN	Drive pulse return. (same as pins 24)
27	FRAME GROUND	Return for EMI T-filter on PULSE RETURN and PULSE OUTPUT.
28	FRAME GROUND	Return for EMI T-filter on PULSE RETURN and PULSE OUTPUT.
29	FRAME GROUND	Return for EMI T-filter on PULSE RETURN and PULSE OUTPUT.

2.3   Typical Characteristics
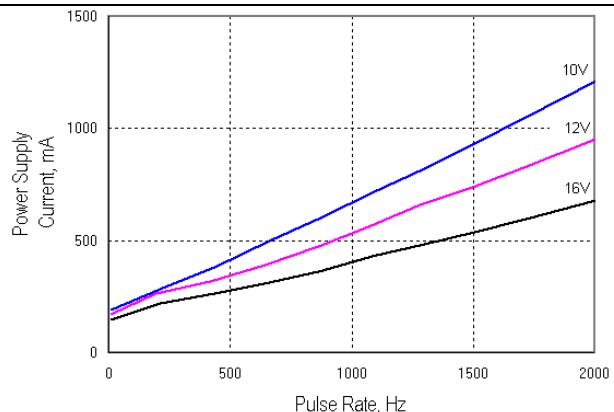
Figure 1   Operating Current vs. Pulse Rate
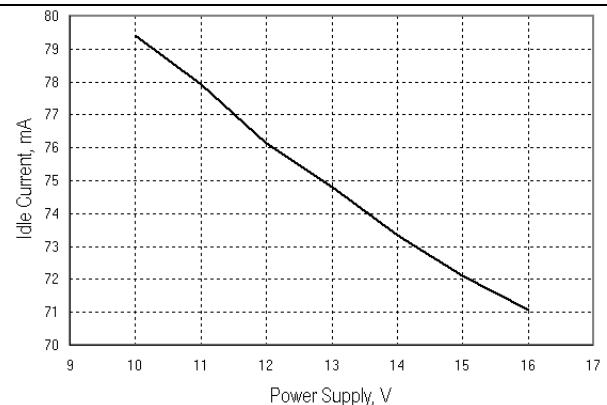
Figure 2   Idle Current as a Function of Input Voltage
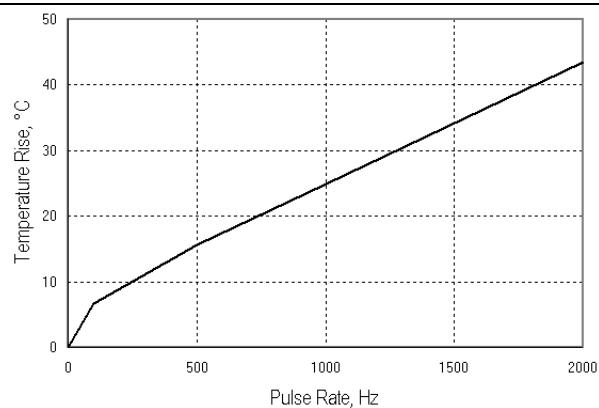
Figure 3   Temperature Rise vs. Pulse Rate
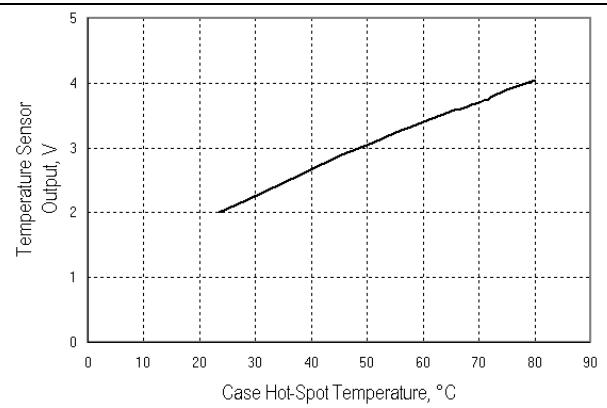
Figure 4   Temperature Sensor Output vs. Case Temperature
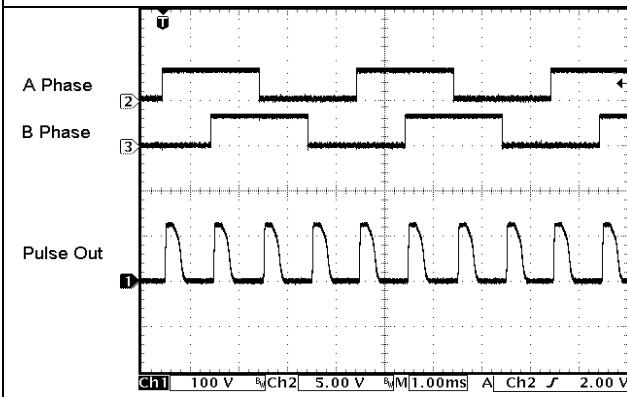
Figure 5   Quadrature Mode, Counter-Clockwise Motion
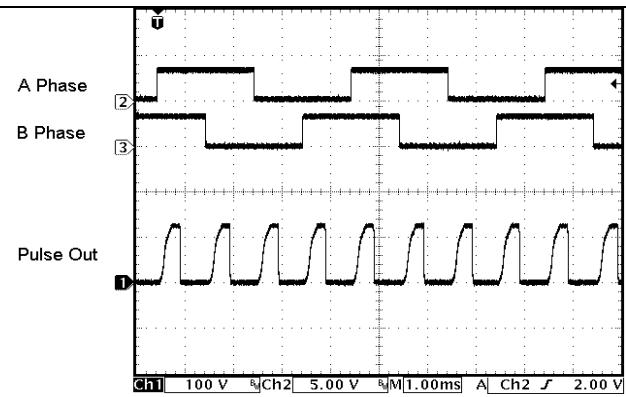
Figure 6   Quadrature Mode, Clockwise Motion

2.4   MODEL 8712 DRAWINGS
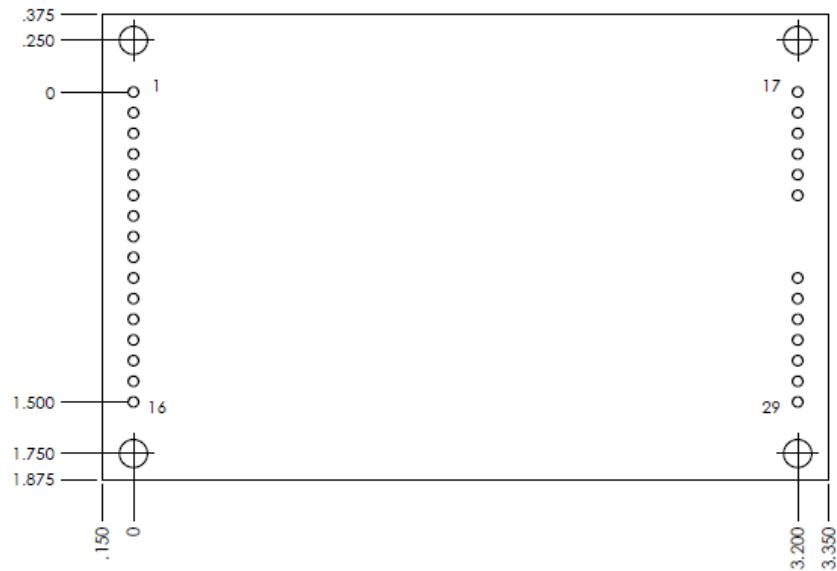
Figure 7   Printed Circuit Board Mounting Pattern (Top View)
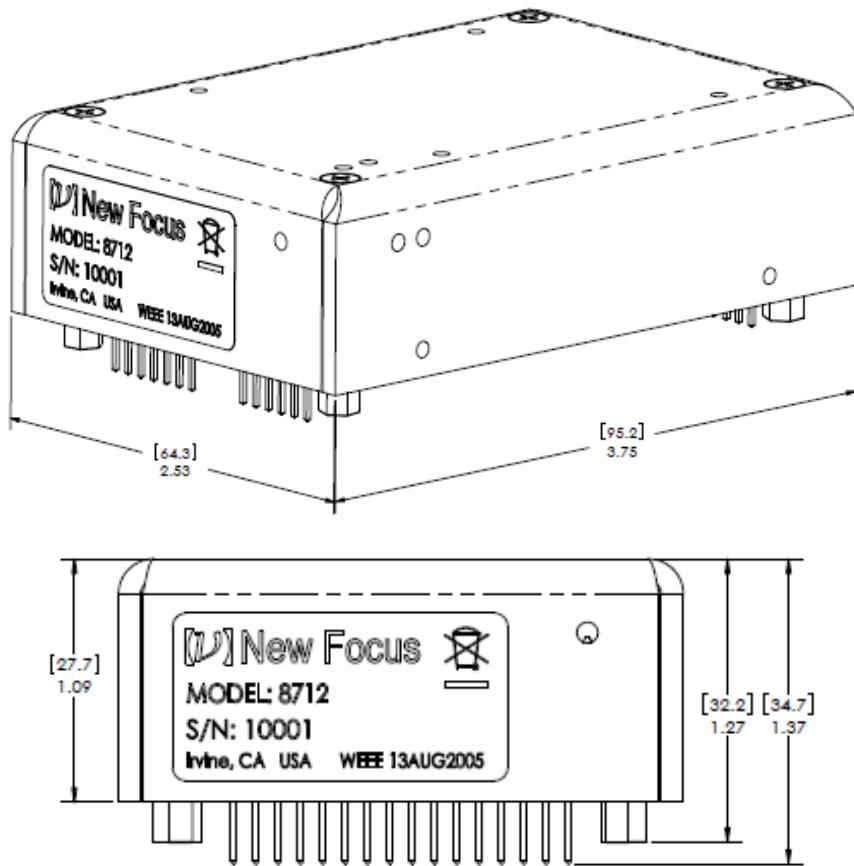
Figure 8   Dimensions of the 8712 Module ([mm] inches)

3   Theory of Operation

3.1   Block Diagram

The block diagram shows the basic design of the 8712. The microprocessor reads the input mode bits when power is turned on and selects the input interface. It also flashes the firmware version number on the internal red LFAULT indicator. To check the firmware version, one has to count the number of led flashes. There is a longer pause between the significant number and the decimal number. For example, version 1.5 will flash the LED once, followed by a pause, then will flash the LED five times.

Pulse and direction inputs (voltage or logic edge) from the selected interface cause the microprocessor to generate low voltage Picomotor drive waveforms. The output amplifier increases the amplitude of the drive waveform sufficiently to drive the Picomotor. An internal power supply generates the high voltage power for the output amplifier as well as other supply voltages.
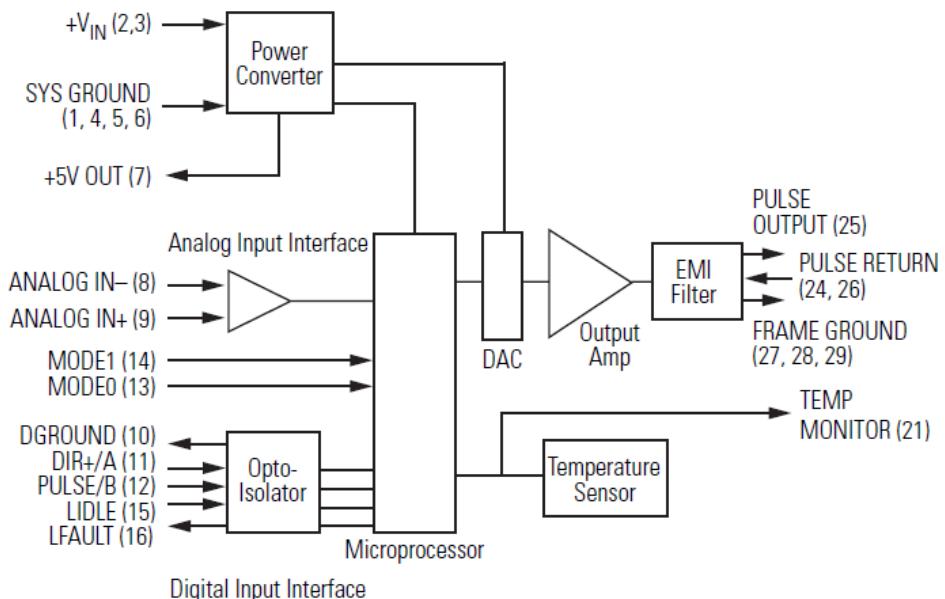
Figure 9   Block Diagram

When LIDLE is pulled low, the microprocessor shuts down the power supply and stops generating Picomotor drive pulses. The response to this input is rapid enough to prevent the generation of more than one pico pulse after LIDLE goes low. Normal operation resumes after LIDLE is brought high.

3.2   Input Mode Control Bits

MODE0 and MODE1 are decoded when the power is applied. The interface mode can only be changed by removing power to the 8712, then changing the mode bits and applying power again. MODE0 and MODE1 define the control interface as follows:

MODE0	MODE1	Description
0	0	Step/Direction Mode
1	0	Quadrature Mode
0	1	Line Voltage Input
1	1	Bang-Bang Voltage Input

### 3.2.1   Step/Direction Mode

In this mode, DIR+/A is the direction input. PULSE+/B is the pulse command input. TTL inputs to the control interface determine pulse generation and the direction of motion. One Picomotor pulse is generated for each falling edge of PULSE+/B. PULSE+/B can be left in either a high or low state because it is edge sensitive. The low state is preferred because the opto-coupler input diode will be off.

DIR+/A causes clockwise motion when high, and counter-clockwise motion when low. It is checked before each pulse is made to allow instantaneous direction reversal. DIR+/A is level sensitive, so it must be in the desired state when PULSE+/B goes low and remain in that state for a minimum of 100 μs after PULSE+/B goes low. The pulse rate can be between 0 and 2 kHz. Faster pulse rates will not result in increased response.

3.2.2   Quadrature Mode

In this mode, DIR+/A is the A-phase input and the PULSE+/B is the B-phase input. Like the step/direction mode, quadrature mode uses the digital control interface. In this mode a pulse is generated for every edge transition of both the A-phase and B-phase control inputs. The direction of motion is determined by the phase of A with respect to B:
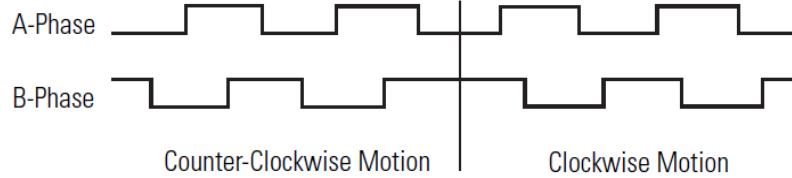
Figure 10   Quadrature-Mode Operation

In normal operation, the drive pulse rate is 4 times the frequency of the A-phase and B-phase waveforms. Do not exceed the A/B-phase frequency of 500 Hz. The Picomotor drive pulse rate cannot go over 2kHz. A perfect quadrature phase relationship between A-phase and B-phase will generate evenly spaced Picomotor drive pulses.

The firmware direction-decoding scheme used in the 8712 rejects edge chatter on the A and B phase inputs. After the 8712 detects an edge transition on A or B phase, subsequent edges are ignored until an edge transition is detected on the other phase.

3.2.3   Linear Voltage Input

The 8712 generates a pulse rate proportional to the input voltage on the ANALOG IN pins in this mode. An input voltage from +10 V to –10 V gives a pulse rate ranging from 0 to 2 kHz. Positive input voltages give clockwise motion. Negative input voltages give counter-clockwise motion. There is a deadband of about ±1 V around 0 V to reject noise. Beyond the deadband threshold, the pulse rate increases with every 78-mV change in voltage:
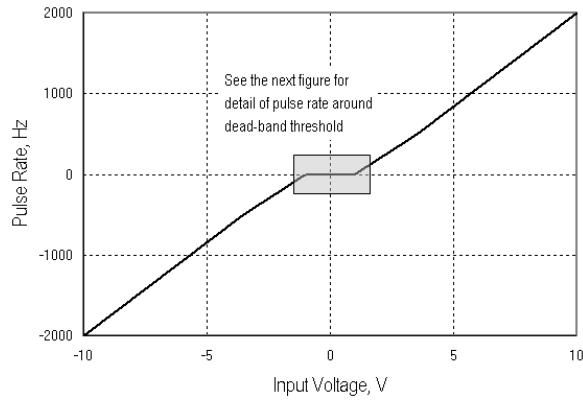
Figure 11   Pulse Rate vs. Input Voltage for Linear Voltage Input Mode
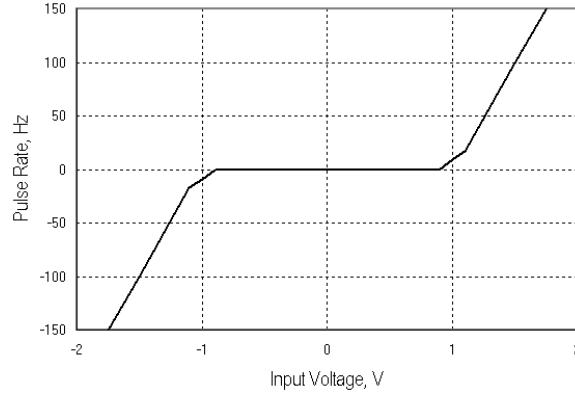
Figure 12   Detailed View of Pulse Rate vs. Input Voltage around the dead-band for Linear Voltage Input Mode

Voltages between 78-mV steps will cause the pulse frequency to switch back and forth between two pulse frequencies. Connect ANALOG IN+ to a low impedance voltage source. Connect ANALOG IN- to the analog signal ground associated with the source of ANALOG IN+. Ground loop noise can be introduced into the analog inputs when SYSTEM GROUND is used instead of analog signal ground. Reverse the ANALOG IN connections to change the polarity sense of the analog input voltage.

3.2.4   Bang-Bang Voltage Input

In this analog input mode, a voltage exceeding the deadband threshold gives the maximum 2 kHz pulse rate. Positive input voltages give clockwise motion. Negative input voltages give counterclockwise motion. This mode should not be used continuously without forced air cooling of the 8712 at ambient temperatures higher than 25 °C. The unit has a temperature time constant of 6 minutes. Operation in Bang-Bang mode is acceptable for less than 50% duty cycle and less than 3 minutes of continuous operation in still air at 55 °C.

For heatsink mounting and recommended parts refer to section 3.4.1 and Figure 14.

3.3   Status Indicators

The red and green LED indicators are visible inside the module's casing through small holes. They provide a visual indication of the unit's status.

Green and red LEDs can be seen through these holes.
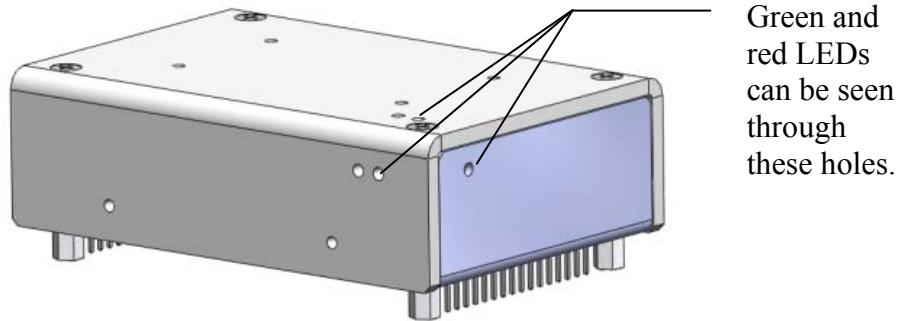
Figure 13   Status Indicators position

The red LED is tied to LFAULT (pin 15). It will flash the firmware revision number when the unit is turning on, and will also turn on if the output amplifier temperature approaches the design limit.(You can also monitor the temperature using the TEMP MONITOR, pin 21. This pin has a 100 kΩ output impedance. The relationship between TEMP MON voltage and output-amplifier temperature is shown in Figure 4.)

The green LED monitors drive pulses. The LED is turned off each time a Picomotor drive pulse is generated. As the pulse frequency is increased, the LED is off a greater fraction of time. This dimming effect is used to visually ensure correct operation.

3.4   Power Supply

The 8712 module can place tremendous stress on the system power supply. The stress has two components:

- **Inrush current:** The inrush current on power-up charges the internal filter capacitor. While the energy magnitude of the inrush current is limited, it can still cause problems with power supplies not designed to handle it.
- **Dynamic load:** Dynamic current is supplied to the 8712 internal power supply for each Picomotor drive pulse. The input-filter capacitor will supply more dynamic current as the resistance between the capacitor and system power supply increases. Do not increase this resistance: it will increase ripple-current stress on the internal input-filter capacitor, leading to early failure of the 8712 module. The best strategy is to keep the resistance between the power supply and the 8712 below 0.1 Ω and specify a system power supply that can handle the dynamic current requirement.

3.4.1   Fault Protection

The 8712 incorporates circuit-protection schemes to protect itself and the system power supply:

- Over-voltage protection: If the power input voltage exceeds 16.7 to 18.5 V, a transient voltage suppressor (TVS) shunts the power input to ground. The internal 2-A fuse will then open. The TVS will also shunt the power input to ground if an internal fault shorts any high voltage to the power input. The input fuse will also open if the input power voltage is reversed. Brief power supply transients will not blow the fuse.

- Inrush resistor: A 5.6 Ω resistor handles all input current until the power supply is operating. This resistor will over-heat and open if an internal fault occurs before the power supply starts operating.

Over-temperature protection: If the case temperature reaches 80 °C (4 V at temperature monitor pin 21), the unit will pull LFAULT low to tell the user that the case, which acts as a heatsink, reached the maximum allowed temperature. The user is expected to take some measures like decreasing the pulse rate, air force cool the 8712 case, or use a heatsink. If the case temperature continues to rise, at 85 °C (4.12 V at temperature monitor) the output will be turned off. The output will remain off until the case temperature will decrease to 75 °C (3.86 V at temperature monitor), when the output will be turned on automatically. If left unattended, the unit will protect itself cycling between 85 °C and 75 °C.

If a heatsink is needed, 8712 has 4 threaded holes on top (see Figure 14) to accommodate a standard half brick heatsink. Examples of heatsinks are Wakefield 528-24AB and 517-95AB. When Wakefield 528-24AB is mounted on 8712 the unit temperature time constant becomes 10 minutes. For 517-95AB heatsink the unit temperature time constant becomes 16 minutes.

Heatsink mounting holes
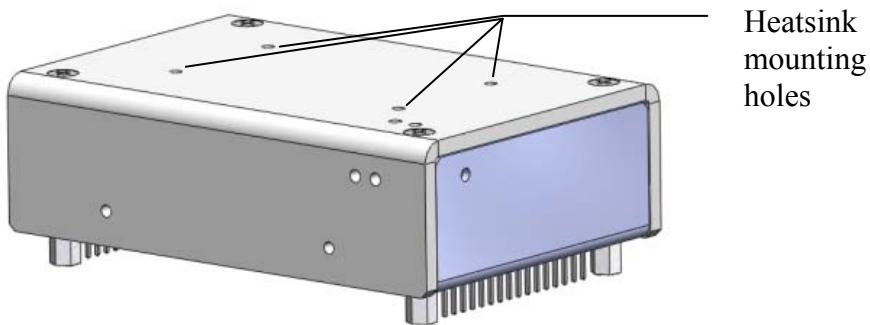
Figure 14   Heatsink mounting holes

3.4.2   Power Connections

Special emphasis on proper power-trace routing is needed due to the high static and dynamic currents demanded by the 8712. Ideally the 8712 will be placed physically close to its power source. The optically isolated control interface makes it possible to place 8712 close to the power supply without

concern for ground loops associated with the control wiring. +V IN and SYS GROUND should be routed one on top of the other (and with at least 0.5"-wide traces).

You can use ground/power planes to route +V IN and SYS GROUND. Use ground/power planes with caution: continuous planes can allow coupling between the 8712 power and neighboring circuits. Power planes with strategically placed slits to control current flow work best. +VIN and SYS GROUND must not cross any plane slits in their paths to the power source.

The 8712 frame is connected to the internal ground. This connection is made to improve shielding and reduce leakage currents in the 8712 frame. The four mounting screws which are connected to the 8712 case should not be connected to anything on the customer's printed circuit board.

No additional filter capacitors are needed between +V IN and SYSTEM GROUND. A common-mode inductor can be used to reduce the effect of switching power-supply noise and dynamic current.

3.5   Control Interface

This section describes the hardware aspects of the control interface:

- MODE1, MODE0. These inputs are not optically isolated and should be connected to SYSTEM GROUND or +5V OUT at the 8712 connector. MODE1,0 should be optically isolated if you want to control these inputs from the host computer. Include the 1 kΩ resistor connected in series to the +5V OUT pin in any opto-coupler design calculations.

- LIDLE, PULSE+/B, DIR+/A. These inputs are optically coupled. They can be directly driven by an HC-TTL buffer like the 74HC244. A 0.06 W 470 Ω resistor is connected in series with the opto-coupler input diode to limit current. With 5V input, this resistor only dissipates 0.03 W. Clearly a higher control voltage could be used to drive the optically coupled inputs. Calculate the current limiting resistor power dissipation and add an external resistor if higher drive voltage is used. 3Volt logic levels are marginal and not recommended for driving the 8712 optically coupled inputs. When using LIDLE as control signal to activate the output pulses, depending on power supply inrush current limit, the typical value of delay time will be typically 400 ms.

- LFAULT is an optically isolated output. It presents an open transistor to the outside world. When on, LFAULT will sink 2.5 mA with 0.2 V collector-emitter voltage. A 10 kΩ pull-up resistor connected to a +5 V logic power supply (not +5VOUT) at the termination of LFAULT will preserve the isolation of this output.

- DGROUND is the return signal for all the optically coupled signals mentioned above. It must be tied to digital ground at the source of LIDLE, PULSE+/B, DIR+/A and the termination of LFAULT. Do not

connect DGROUND to SYSTEM GROUND at the 8712 unless you are just trying to make a simple hook-up to test operation of the 8712.

3.6   Output Connections

PULSE OUTPUT and PULSE RETURN connect the 8712 to the external Picomotor connector. These signals carry a peak current of 2 A with 15-μs rise-time and should be routed with care. Route one on top of the other with minimum 0.15" trace width. Do not route any traces parallel to PULSE OUTPUT or PULSE RETURN without at least 0.2" of clearance.

Ground/power planes covering these traces can provide excellent shielding at the risk of increased coupling of the pulse output to the shielding planes.

The 8712 incorporates current-limiting resistors to protect the customer's system from serious damage. If the PULSE OUTPUT is shorted, the resistors will over-heat and open.

3.7   Sockets

The 8712 can be connected to your printed circuit board with female header sockets:

Make	Model	Digi-Key #
3M	80620078958	929850-01-36-ND
Mill-Max	801-036-10-012000	ED7636-ND
Mill-Max	801-93-050-10-0001	ED7150-ND

These headers come in standard lengths of 36 or 72 pins and can be cut as needed for the 8712.

The New Focus Picomotor usually comes with a high reliability RJ-11 plug. The mating receptacle for printed circuit board mounting is available from many sources:

Make	Model	Digi-Key #
Hirose (side entry)	TM5RJ3-44	H9081-ND

3.8   EMC Considerations

The 8712 was designed for use as a component of a larger system, and incorporates several design features to improve the overall system's EMC performance:

- Output filter: Both PULSE OUTPUT and PULSE RETURN incorporate inductor capacitor T-networks. The T-networks largely attenuate both ESD pulses entering the 8712 and microprocessor clock harmonics leaving the 8712. The bottom of the T-network connects to the 8712 ground.

- Frame ground connection: Several pins connect frame ground to the internal 8712 ground via a 0.1-µF capacitor. This connection is close to that of the output T-filters mentioned above. Microprocessor clock harmonics are shunted back to internal ground by the T-network. ESD energy is shunted to frame ground when the FRAME GROUND pins are connected to the customers frame ground. This connection must be low inductance (i.e. short and wide).

- Optically coupled control interface: As mentioned above, optical coupling is used to break the low frequency ground loop inherent in locating the 8712 close to its power source. Further benefits in the EMC aspect of system design are the reduction in I/O coupling to the more sensitive control section of most systems, and the reduction of controller clock harmonics coupling to the 8712 output.

Additional protection may be needed to provide acceptable EMC performance of a system incorporating the 8712. An additional set of output T-filter networks close to the Picomotor connector and equipment bulkhead will shunt ESD energy before it enters the system. A common-mode power-line filter will reduce radiation/conduction of switching-power-supply harmonics.

Attention to printed circuit board layout details, as mentioned in previous sections, will go a long way to ensuring success at the EMC test lab.

4   MODEL 8703 SYSTEM

4.1   Model 8703 System Hook Up

The Model 8703 incorporates the Model 8712 Picomotor Driver Module with a printed-circuit board for quick and easy hook up into your system. The board includes connectors and an on-board on-off switch to reset power whenever necessary. There are four I/O connectors on the Model 8703 system board: J100, J101, J102, and J103. J100 is for the power supply and J101 is for controlling and monitoring the Model 8703. J102 and J103 are for pulse output to drive the Picomotor. The terminal functions for J100 and J101 are described below.

4.1.1   I/O Connector Descriptions

Name	J100	J101	J102	J103
Description	2-Pin Header	9-Pin Header	4-Pin receptacle	3-Position terminal
Make	Phoenix Contact	Phoenix Contact	Hirose	Phoenix Contact
Model#	MSTBA 2,5/2-G-5,08	MSTBA 2,5/9-G-5,08	TM5RJ3-44	MKDSN 1,5/3
Digi-Key #	277-1106-ND	277-1113-ND	H9081-ND	277-1237-ND

4.1.2   I/O Connector Terminal Functions (Connectors J100 & J101)

Connector	Terminal	Name	Description
J100	1	GROUND	Power return
	2	12 VOLTS	Input power, 10–12 V
J101	1	ANALOG IN–	Voltage-controlled rate input. Connect to analog common. **Note:** This is connected to the ANALOG IN- of the 8712 module.
	2	ANALOG IN+	Voltage-controlled rate input. Connecting to analog voltage ±10 V gives full-scale rate of 2 kHz. The input impedance is 14.1 kΩ to ground. Note: This is connected to the ANALOG IN+ of the 8712 module.
	3	OPTO RET	Opto-coupler return. Connect to digital ground close to control logic.
	4	DIR/A	Opto-coupled TTL control input defined by MODE 0,1 inputs. In Step/Direction mode, controls direction: high=clockwise, low=counterclockwise. In Quadrature mode, acts as quadrature A.
	5	PULSE/B	Opto-coupled TTL control input defined by MODE0,1 inputs. In Step/Direction mode, each falling edge initiates a step. In Quadrature mode, acts as quadrature B.
	6	LIDLE	Opto-coupled TTL input. Low input disables pulse generation and reduces power consumption. Can also be used as system interlock.
	7	LFAULT	Open-collector opto-coupler output pulled low when output amplifier temperature limit is exceeded. On start-up, firmware version number is present on this pin in the form of on/off pulses.
	8	TEMP+	Voltage proportional to the output-amplifier case temperature. A voltage greater than 4 V (at 80 ºC) pulls LFAULT low. A voltage greater than 4.12 V (at 85 ºC) turns the output off. The output is turned on if the voltage decreases to 3.86 V (at 75 ºC).
	9	TEMP RETURN	Ground reference for terminal 11. Do not tie to GROUND (terminal 1).

4.1.3   Setting the Control Mode

Set the Model 8703 control mode using the DIP switches located at S100. These switches control the MODE0 and MODE1 driver inputs.

4.1.4   Power Input

Supply power to the Model 8703 via the 2-pin connector, J100. Connect Pin 1 to the power source ground, and connect Pin 2 to the +10 V to +12 V power source. Diode D107 and D108 protect the Model 8703 against reversed power wiring.

4.1.5   Analog Control

Connector J101 provides interface for control and monitor signals. Pins 1 and 2 are inputs for the analog voltage used to set the pulse rate. These inputs are only used when the DIP switches at S100 are set for LINEAR (off on) or BANG-BANG (off off). Connect ANALOG IN+ to a positive voltage and connect ANALOG IN- to the analog ground associated with the ANALOG IN+ voltage source: reverse the polarity to change the direction of the Picomotor. D100 and D101 are bipolar TVS diodes that shunt voltage spikes to GROUND. D100 and D101 are most useful when long wires are used to connect Pins 1 and 2 to the pulse-rate-controlling voltage source.

4.1.6   Digital Control

Pin 3 is the return line for the DIR/A, PULSE/B, LIDLE, and LFAULT opto-isolators. Connect it to the logic ground for the source of these signals (destination for LFAULT). Pin 3 can be connected to terminal 1 GROUND if a simple set-up is needed. DIR/A, PULSE/B, LIDLE, and LFAULT will function only if terminal 6 is connected to the proper ground.

Pins 4 and 5 are used for step and direction input when the DIP switches are set for DIR/PULSE (on on) or QUAD (on off). See the data sheet for a detailed discussion of the digital control modes. R100 and R101 limit the current flow through the opto-isolator inputs. If 5V logic (TTL) drives Pins 4 and 5, the current-limiting resistors in the Model 8703 are sufficient. R100 and R101 should be increased if higher voltage logic is used. For example, suppose you want to use 12V logic:

The 8712's internal 470 Ω 0603-package resistor's maximum dissipation=0.063 W.

The opto-isolator diode drop=1.4 V.

You should calculate R such that the internal resistor dissipation is 50% of maximum, at 0.032W.

$$\text{Current I} = \sqrt{\frac{0.032\,\text{W}}{470\,\Omega}} = 8.2\,\text{mA}$$

$$\text{R} = \frac{12\text{V} - 1.4\text{V} - 470\,\Omega \cdot 8.2\,\text{mA}}{8.2\,\text{mA}} = 822\,\Omega$$

Rounding to the nearest 10% standard resistor value results in a value of R=820 Ω.

820 Ω x (8.2 mA2) = 0.055 W, so the 0603 package is marginal and you should use 0805.
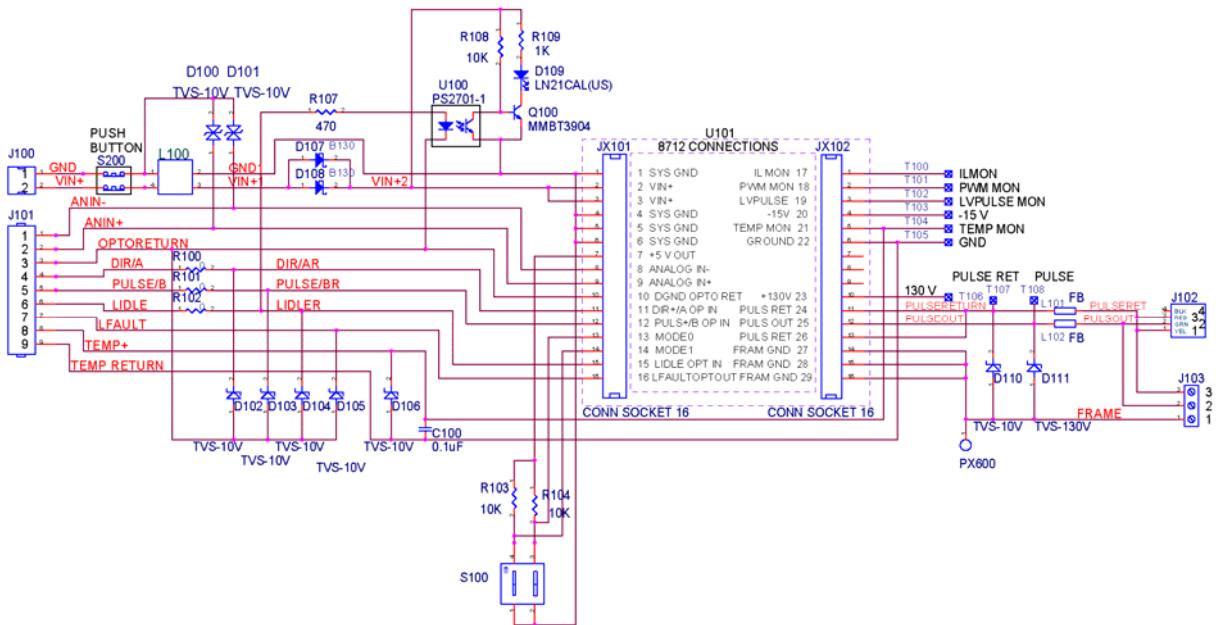
Figure 15   Schematic of Model 8703 System Board

4.1.7   LIDLE

Pin 6, LIDLE, is connected to the positive logic voltage to enable 8712 operation and left floating or grounded to disable the 8712. The 8703 will not operate if Pin 6 is grounded or floating. Opto-isolator U100, Q100, R107-9 light diode D109 to indicate when Pin 6 is grounded or floating while preserving the isolation barrier. R102 serves the same purpose as R100 and R101. The same calculations apply for determining the value of R102. You can just connect an 820Ω resistor between the 12V supply and Pin 6 to disable LIDLE.

4.1.8   LFAULT

Pin 7 is the open collector opto-isolated LFAULT output. It goes low when the case temperature limit is exceeded. LFAULT pulses when power is first applied to indicate the firmware revision number. The data sheet gives an example of the pulsed startup waveform. The customer must provide a pull-up resistor on the LFAULT output. The pull-up resistor is connected to the logic power supply near the destination of the LFAULT signal.

An example calculation of the pull-up resistor value is given below:

Opto-isolator diode current = 7 mA

Vce saturated = 0.3 V with Ic = 4 mA when the diode current = 7 mA

With 5V logic,

$$R = \frac{5V - 0.3V}{4mA} = 1.18k\Omega$$

Rounding to the nearest 10% value, 1.2 kΩ,

$$1.2k\Omega \cdot (4mA)^2 = 0.019W$$

Therefore the 0603 package is can be used in this application.

For 12V logic,

$$R = \frac{12V - 0.2V}{4mA} = 2.9k\Omega$$

Rounding to the nearest 10% value, R=2.7 kΩ,

$$2.7k\Omega \cdot (4mA)^2 = 0.043W$$

So the 0603 package is marginal and you should use 0805.

4.1.9   Temperature Sensor

Pin 8 is connected to the 8712 temperature sensor output. The output impedance is 100 kΩ, so use a high impedance input to monitor this terminal. See Figure 4 for a typical voltage vs. temperature plot. The thermistor used in the 8712 temperature sensing circuit has a ±10% tolerance. C100 is connected across Pins 8 and 9 to improve noise filtering. TVS diode D106 is connected across Pins 8 and 9 to attenuate voltage spikes. D106 is not needed if short wires are used to connect Pins 8 and 9 to the input of the voltage measuring circuit.

Pin 9 is the ground reference for the temperature sensor.

4.2   Picomotor Connections

For the convenience of your application, the Model 8703 system board provides two connectors, J102 and J103, to connect the 8703 Drive Module to the Picomotor.

J103 has 3 screw terminals for connection to the Picomotor wires and an optional cable shield.

Terminal	Name	Description
1	FRAME GROUND	Return for EMI T-filter on PULSE RETURN and PULSE OUTPUT.
2	PULSE OUTPUT	Drive pulse.
3	PULSE RETURN	Drive pulse return.

<table>
<tr><td>⚠</td><td>

CAUTION

The Picomotor will be damaged if the PULSE RETURN and PULSE OUT connections are reversed. Check with New Focus if you have any questions about Picomotor wiring when using J103.

Also, be careful when connecting a scope probe to the unit output. The probe clip is connected to the scope chassis ground. If the probe clip is accidentally connected to the 8712 Pulse Output, the output stage may be damaged.
</td></tr>
</table>

4.2.1   Isolation

The system board includes some circuitry to isolate the 8712 from the Picomotor cabling. L102 and L101 ferrite beads increase the impedance to a few hundred Ohms at high frequencies. D111 and D110 TVS diodes shunt high voltage pulses to the frame ground terminal PX600. The frame ground is also connected to the 8712 to ground the internal filter-T networks.

The pulse output, pulse return, and frame traces are low inductance. Pulse output and return carry 2 A transient currents and must be tightly coupled. The frame connection is also low inductance; it carries high current with wide bandwidth when ESD events occur. The connection to system frame ground is made with screw terminal PX600. Use a short wire or metal binding post to connect PX600 to the equipment frame.

## 4.3   Model 8703 System Board Layout
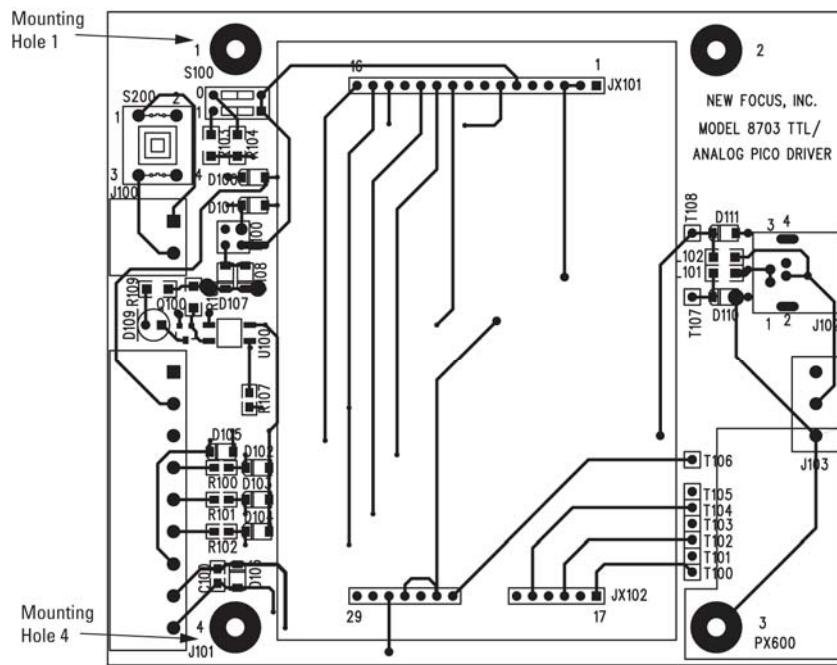
*Figure 16   System Board (Upper Layer, Top View)*
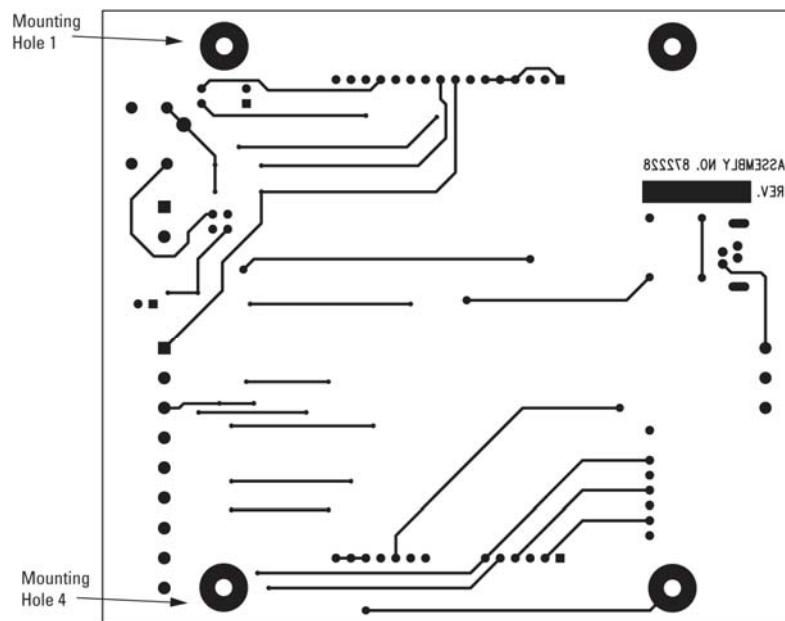
*Figure 17   System Board (Bottom Layer, Top View)*
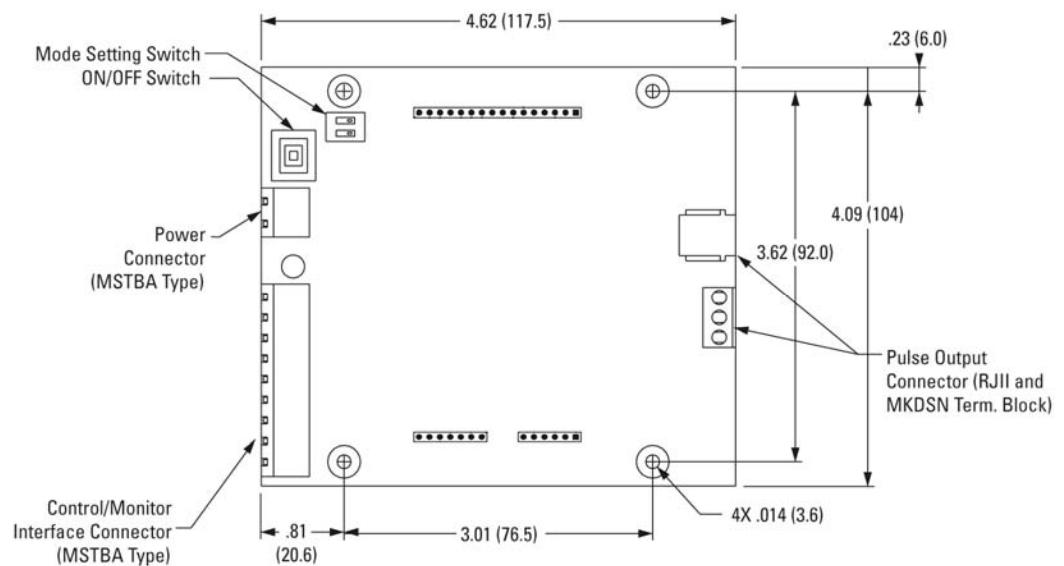
Figure 18   Dimensions of Model 8703.

5   Safety Precautions

5.1   Definitions and Symbols

The following terms and symbols are used in this documentation and also appear on the Models 8712 and 8703 where safety-related issues occur.

5.1.1   General Warning or Caution

Figure 19   General Warning or Caution Symbol

The Exclamation Symbol in the figure above appears on the product and in Warning and Caution tables throughout this document. This symbol designates that documentation needs to be consulted to determine the nature of a potential hazard, and any actions that have to be taken.

5.1.2   Electric Shock

Figure 20   Electrical Shock Symbol

The Electrical Shock Symbol in the figure above appears throughout this manual. This symbol indicates a hazard arising from dangerous voltage. Any mishandling could result in irreparable damage to the equipment, and personal injury or death.

5.1.3   European Union CE Mark

Figure 21   CE Mark

The presence of the CE Mark on Newport Corporation equipment means that this instrument has been designed, tested and certified compliant to all applicable European Union (CE) regulations and recommendations.

5.1.4 Waste Electrical and Electronic Equipment (WEEE)

Figure 22   WEEE Directive Symbol

This symbol on the product or on its packaging indicates that this product must not be disposed with regular waste. Instead, it is the user responsibility to dispose of waste equipment according to the local laws. The separate collection and recycling of the waste equipment at the time of disposal will help to conserve natural resources and ensure that it is recycled in a manner that protects human health and the environment. For information about where the user can drop off the waste equipment for recycling, please contact your local Newport Corporation representative.

5.1.5 Control of Hazardous Substances

Figure 23   RoHS Compliant Symbol

This label indicates the products comply with the EU Directive 2002/95/EC that restricts the content of six hazardous chemicals.

5.2 Warnings and Cautions

The following are definitions of the Warnings, Cautions and Notes that are used throughout this manual to call your attention to important information regarding your safety, the safety and preservation of your equipment or an important tip.

⚠	**WARNING** **Situation has the potential to cause bodily harm or death.**

⚠	**CAUTION** **Situation has the potential to cause damage to property or equipment.**

NOTE

Additional information the user or operator should consider.

5.2.1   General Warnings

Observe these general warnings when operating or servicing this equipment:

- Heed all warnings on the unit and in the operating instructions.
- Do not use this equipment in or near water.
- Although the input power to this equipment is below 20 VDC, this equipment internally generates much higher voltages that are present on the Model 8712 connector pins AND various components and connectors on the Model 8703 System Board. Only properly trained personnel should touch either of these items.
- The Model 8712 is intended to be used as a component in a larger system. When this product is included as part of a larger assembly, the user MUST ensure that appropriate additional safety and EMC-compliance features are incorporated the assembly.
- The Models 8712 and 8703 are powered from an external DC source that is not part of either product. When the external power source is connected to MAINS power, the user must ensure that an appropriate disconnect switch and fuse are incorporated into the external power source.
- Disconnect power before cleaning the equipment. Do not use liquid or aerosol cleaners; use only a damp lint-free cloth.
- Lockout all electrical power sources before servicing the equipment.
- There are no user-replaceable fuses in this equipment. The user must ensure that appropriate current-limiting protection is provided by the external DC power source.
- To avoid explosion, do not operate this equipment in an explosive atmosphere.
- Qualified service personnel should perform safety checks after any service.

5.2.2   General Cautions

Observe these cautions when operating this equipment:

- If this equipment is used in a manner not specified in this manual, the protection provided by this equipment may be impaired.
- Do not block ventilation openings.
- Use only the specified replacement parts.
- Follow precautions for static sensitive devices when handling this equipment.

- This product should only be powered as described in the manual.
- There are no user-serviceable parts inside the Model 8712 Picomotor Drive Module.

5.2.3   Summary of Warnings and Cautions

The following general warning and cautions are applicable to this instrument:

⚠	**WARNING** **The Picomotor Driver is incomplete in constructional features and is considered only to be a component for the purposes of regulatory compliance. It is "equipment for building in;" a suitable enclosure must be provided so that the unit is not user accessible when incorporated into the final product.**

⚠	**WARNING** **The Model 8712 Picomotor Driver internally generates non-SELV voltages and shall be installed with the enclosure, mounting, spacings, and marking requirements of the end-use application.**

⚠	**WARNING** **The Model 8703 Picomotor Driver kit has exposed non-SELV voltages that may exceed 130 volts. This unit is only for use by trained, experienced personnel. The unit should not be powered when untrained personnel can access it.**

⚠	**WARNING** **Do not attempt to operate this equipment if there is evidence of shipping damage or you suspect the unit is damaged. Damaged equipment may present additional hazards to you. Contact Newport technical support for advice before attempting to plug in and operate damaged equipment.**

⚠	**WARNING** **Before operating the Model 8712 Picomotor Driver, please read and understand all of Section 5.**

WARNING

Do not attempt to operate this equipment if there is evidence of shipping damage or you suspect the unit is damaged. Damaged equipment may present additional hazards to you. Contact Newport technical support for advice before attempting to plug in and operate damaged equipment.

WARNING

Do not apply external DC power to this equipment in excess of 16 VDC.

CAUTION

There are no user serviceable parts inside the Model 8712 Picomotor Driver. Work performed by persons not authorized by Newport Corporation will void the warranty.

WARNING

If this equipment is used in a manner not specified in this manual, the protection provided by this equipment may be impaired.

WARNING

This instrument is intended for use by qualified personnel who recognize thermal, shock, or laser hazards and are familiar with safety precautions required to avoid possible injury. Read the instruction manual thoroughly before using, to become familiar with the instrument's operations and capabilities.

CAUTION

The Models 8712 and 8703 Picomotor Driver are designed to be safe when operated under Normal Environmental Conditions as defined in EN61010-1:2010. Operation under harsher environmental conditions can result in severe injury.

CAUTION

When operated at higher pulse rates for extended periods of time, the temperature on the outside of the Model 8712's case may rise above the "surface temperature limits in normal operation" as defined in EN61010-1:2010 unless the user takes appropriate measures. These may include the addition of an external heat sink, barriers to contact, reducing the pulse frequency, or other appropriate mitigations. Failure to take appropriate action when operating the Model 8712 under these conditions can result in severe injury.

The Models 8712 and 8703 Picomotor Drivers are intended for use in an industrial laboratory environment. Use of this product in other environments, such as residential, may result in electromagnetic compatibility difficulties due to conducted as well as radiated disturbances.

The Models 8712 and 8703 Picomotor Drivers are designed to operate in a controlled electromagnetic environment; i.e., where R.F. transmitters such as mobile telephones may not be used in close proximity.